

# **CONTENTS**

## **APPROVAL PAGE**

## **ORIGINALITY STATEMENTS**

<b>ABSTRACT</b>	<b>iv</b>
-----------------	-----------

<b>PREFACE</b>	<b>v</b>
----------------	----------

<b>ACKNOWLEDGE</b>	<b>vi</b>
--------------------	-----------

<b>CONTENTS</b>	<b>viii</b>
-----------------	-------------

<b>LIST OF FIGURES</b>	<b>x</b>
------------------------	----------

<b>LIST OF TABLES</b>	<b>xi</b>
-----------------------	-----------

<b>1 INTRODUCTION</b>	<b>1</b>
-----------------------	----------

1.1 Background . . . . .	1
1.2 Problem Formulation . . . . .	3
1.3 Objective and Benefit . . . . .	3
1.4 Scope of Problem . . . . .	3
1.5 Research Method . . . . .	4
1.6 Writing Systematics . . . . .	4

<b>2 BASIC THEORY</b>	<b>6</b>
-----------------------	----------

2.1 Ground Penetrating Radar . . . . .	6
2.2 Working Principle of Ground Penetrating Radar . . . . .	6
2.3 Signal Processing . . . . .	7
2.3.1 A-scan . . . . .	8
2.3.2 B-scan . . . . .	9
2.3.3 C-scan . . . . .	10
2.4 Modelling Using VNA . . . . .	11
2.5 Stepped Frequency Continuous Wave Radar (SFCW) . . . . .	13
2.6 Clutter Suppression Technique . . . . .	13

<b>3 SYSTEM DESIGN AND IMPLEMENTATION</b>	<b>15</b>
3.1 Framework . . . . .	15
3.2 Experiment Design . . . . .	15
3.3 Retrieved Data . . . . .	16
3.3.1 Retrieved A-scan Data . . . . .	16
3.3.2 Retrieved B-scan Data . . . . .	17
3.4 Implementation of VNA Experiment . . . . .	18
3.4.1 Installation of Tools . . . . .	18
3.4.2 Calibration . . . . .	18
3.4.3 A-scan . . . . .	19
3.4.4 B-scan . . . . .	20
<b>4 RESULT AND ANALYSIS</b>	<b>22</b>
4.1 The $S_{21}$ data retrieval on the ground . . . . .	22
4.2 B-scan Data Retrieval . . . . .	26
4.3 Surface Clutter Reduction Analysis . . . . .	28
<b>5 CONCLUSION AND SUGGESTION</b>	<b>32</b>
5.1 Conclusion . . . . .	32
5.2 Suggestion . . . . .	32
<b>BIBLIOGRAPHY</b>	<b>33</b>
<b>APPENDIX A</b>	
<b>APPENDIX B</b>	